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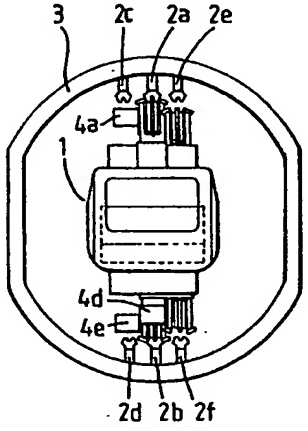
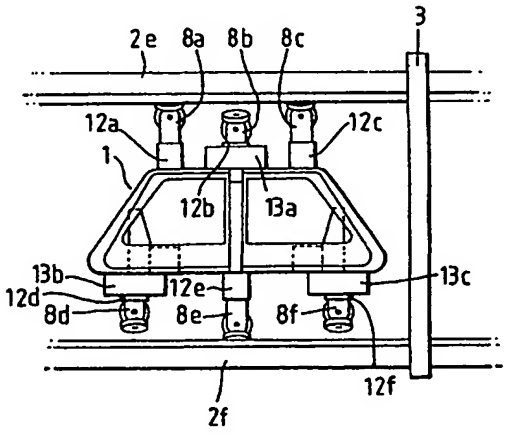
(54) Title: VEHICLE TRACKING SYSTEMS





(57) Abstract

A vehicle tracking system comprises a plurality of vehicles (1) driven on tracks defined by upper and lower track members (2a, 2b) by drive units (8a – 8f) each comprising two drive wheels and two locating wheels which are driven by respective drive motors (4a – 4f). The drive units are powered by electricity which is supplied from a conductor positioned on the track members (2a, 2b). Each drive unit is arranged to move between a position where it engages the track member and a position removed from the track member, in which position it can move laterally in relation to the track member so as subsequently to re-engage a track member, e.g. (2e), of an adjacent track. Disengagement and subsequent re-engagement are effected by means of ram mechanisms (12a – 12f), three of which (12b, 12d and 12f) are arranged to move laterally using slide mechanisms (13a, 13b, and 13c). At bends in the track, the upper and lower track members (2a, 2b) are positioned off-centre so as to provide banking of the vehicle to compensate for circular motion.

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VEHICLE TRACKING SYSTEMS

The present invention relates to vehicle tracking systems and in particular to tracking systems which enable tracked vehicles to transfer from one track to another.

The present invention additionally relates to vehicle tracking systems which enable tracked vehicles to travel at predetermined speeds along tracks which include bends.

A particular application for the present invention is in rapid transport systems wherein a plurality of vehicles are guided at substantially constant speed. Such vehicles are typically small units designed to carry up to five people.

The systems are arranged to transport the vehicles between locations at substantially constant speed.

Such arrangements typically suffer from the disadvantage of requiring moving sections of track in order to allow vehicles to transfer between sections of track, and this in turn requires signalling systems.

To overcome this problem, one known system comprises a plurality of small electrically driven cars which travel on wheels on flat road tracks and can transfer from a first road track to a second road track by locking on to a side barrier which draws the vehicle from the first track to the second.

Such an arrangement is limited in that the vehicles are maintained on the track simply by gravity, and this imposes a speed restriction when cornering.

It would therefore be desirable to provide a system which overcomes, or at least mitigates, some or all of the above problems.

In accordance with a first aspect of the present invention, there is provided a tracked vehicle system comprising:

first and second fixed tracks for guiding vehicles along first and second paths respectively;

a vehicle comprising a plurality of track-engaging members; and

means for causing the track-engaging members to disengage the first track and subsequently to engage the second track thereby to cause the vehicle to travel along the second path.

Such an arrangement thus provides a tracked vehicle system which does not require any movement of the tracks, and therefore no complex points arrangements or consequential signalling systems.

The track preferably comprises two track members and said plurality of track-engaging members preferably comprises at least four such members, each track member having at least one track-engaging member associated therewith, since this enables track transfer to take place with three track-engaging members engaged with the associated track members at any one time. However, such a transfer involves four separate stages, since only one track-engaging member can be moved at a time.

It is therefore preferred that each vehicle has two sets of three members, each set being arranged to engage a respective track member. With this arrangement, it is possible to effect the track transfer in two stages by selecting two track-engaging members from one set and one track-engaging member from the other set to disengage the first track and to engage the second track before the other three track-engaging members perform the disengagement and subsequent re-engagement. In this way, at least three track-engaging members are engaged to one of said tracks at any one time.

In accordance with a second aspect of the present invention, there is provided a track for guiding vehicles along a path, the track comprising a first track member arranged above the path and a second track member arranged below the path.

Such an arrangement enables a vehicle to be guided securely along the path, while permitting the vehicle to transfer between adjacent tracks.

Such a path will typically have one or more bends, and, in order to allow the vehicle to travel along the path stably at a substantially constant predetermined speed, the track members will preferably be positioned off-centre at the bends by an amount which causes the vehicle to be oriented at the optimum angle for compensation of the circular motion of the vehicle.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings, wherein:

Figure 1 is a cross-sectional view and a side view of a vehicle suspended between upper and lower track members in accordance with a preferred embodiment of the present invention;

Figure 2 is a cross-sectional view of the arrangement of Figure 1 showing banking of the vehicle;

Figure 3 shows in detail the components of a track-engaging member of a vehicle and the upper track members of three adjacent tracks in accordance with a preferred embodiment of the present invention; and

Figures 4(a) to (e) show the sequence of connections made between the track-engaging members of the vehicle and the track members when the vehicle transfers from a first track to a second track.

Referring to Figure 1, a vehicle 1 travels along a track 2 in the form of two track members 2a, 2b positioned respectively above and below the vehicle and mounted within housings, such as a series of circular frames 3 positioned along the track at intervals. The vehicle is driven along the track by six electric motors 4a - 4f which drive six respective track-engaging members in the form of wheel groups 5a - 5f. Each wheel group comprises four wheels which bear on four respective portions of the track members 2a, 2b. Electric power is supplied to the vehicle via the track 2, as described in more detail below. Ram mechanisms 12a - 12f and slide mechanisms 13a - 13c are shown in this drawing, and will be described below.

Figure 2 illustrates the track arrangement at a bend in the path of the vehicle. The track members 2a, 2b are displaced from the centre position of Figure 1 by an amount which compensates for the circular motion of the vehicle at the bend. The exact positioning of the track members 2a, 2b depends on the predetermined speed of the vehicle and is chosen such that the force between the lower track member and the vehicle is directed along the plane joining the two track members. This force is the resultant of (i) the horizontal centripetal force required to maintain the circular path of the vehicle around the bend and (ii) the vertical reaction force opposing the weight of the vehicle.

The positioning of the track members 2a, 2b can be effected either by adjusting the positions of the track members 2a, 2b within the circular frames 3 at the bend or by rotating the circular frames 3.

Figure 3 shows in greater detail the arrangement of one of the wheel groups 5a - 5f constituting the track-engaging members of the vehicle. As can be seen from the drawing, the track member 2a is Y-shaped in cross-section, and two drive wheels 5i and 5ii of the wheel group 5a bear on the end faces of the Y-shaped track member 2a. The two drive wheels 5i and 5ii are provided with a rubberised or other synthetic traction surface, so as to reduce wear on the track 2.

Two smaller locating wheels 5iii and 5iv project at an angle in relation to the drive wheels 5i, 5ii and bear on the chamfered sides of the track member 2a. This arrangement permits self-aligning of the wheel groups 5a - 5f on the associated track members 2a, 2b. The two drive wheels 5i and 5ii are driven directly by an electric motor 4a which is dedicated to this wheel group 5a. The motor is located on the vehicle so that the drive shaft 6 is coaxial with the two drive wheels 5i and 5ii.

The rotation of the two drive wheels 5i and 5ii is transmitted to the two locating wheels 5iii and 5iv by means of two respective drive gears 7a, 7b which are positioned coaxially with respect to the two locating wheels 5iii and 5iv, the arrangement being such that the drive speed of the drive wheels 5i, 5ii is the same as that of the locating wheels 5iii, 5iv. Each wheel group 5a - 5f, its corresponding electric motor 4a - 4f and

drive gears 7a, 7b define collectively a set of respective drive units 8a - 8f.

Electric power is supplied to the motor 4a from the track member 2a by means of a first elongate electrical conductor 9 lying along the track between the two limbs of the Y shape but insulated from the track member 2a itself by means of an insulating channel 10 positioned between the track member 2a and the first conductor 9. Positioned between the two larger wheels 5i, 5ii of the wheel group 5a is a second electrical conductor 11 which contacts the first electric conductor 9 and conducts electric current to the motor 4a. The second electrical conductor 11 is spring-biased towards the first electrical conductor 9 so as to maintain an effective conduction path. Also shown in Figure 3 are two track members 2c and 2e which are adjacent the track member 2a. In the arrangement described below, it will be shown how the drive units 8a to 8f can be transferred from one track, e.g. 2a, 2b to another, adjacent track member, e.g. 2e, 2f.

Referring to Figure 4(a) to 4(e), the arrangement by which the vehicle can be transferred between tracks will now be described.

As shown in the drawings, a vehicle is located at a region of the track layout where there are three adjacent tracks each comprising two track portions 2a, 2b; 2c, 2d; and 2e, 2f. In Figure 4(a) the vehicle is shown engaged to track members 2a, 2b, and the procedure whereby the vehicle is transferred to track members 2c, 2d is illustrated in Figures 4(b) to 4(e).

Each of the six drive units 8a - 8f can be moved into and out of engagement with a track member by means of a respective ram mechanism 12a - 12f driven either by hydraulic means or by a stepper motor. Three of the six ram mechanisms 12a, 12c and 12e are mounted in fixed positions on the vehicle, and the other three ram mechanisms 12b, 12d and 12f are mounted on slides 13a - 13c which enable the associated ram mechanisms 12b, 12d and 12f to be moved laterally with respect to the vehicle to a position above or below the adjacent rail to which the vehicle is to be transferred. The slide mechanisms are either hydraulic or mechanical, such as a screw mechanism. Alternatively, a turntable arrangement could be provided, the base of the ram mechanism being geared so as to maintain it in the appropriate position in relation to the track

members. As a fail-safe arrangement, each ram mechanism is in its resting, or stable, state when extended, i.e. when the wheel group is engaged with a corresponding track member, such that, in the event of a system failure, the vehicle 1 will remain locked to the track 2.

In Figures 4(a) to 4(e) the ram mechanisms 12a - 12f and the slide mechanisms 13a - 13c are shown located on the outside of the vehicle. However, it is preferred that these mechanisms are located within the body of the vehicle, so as to reduce the over-all volume of the system. This arrangement is shown in Figure 1.

Once a drive unit, e.g. 8a has become disengaged from the track member, e.g. 2a, it is moved laterally into a position appropriate for re-engagement with one of the track members 2e, 2f of an adjacent track. As shown in Figure 4(b), a first set of three drive units 8b, 8d and 8f are firstly disengaged, while the second set of drive units 8a, 8c and 8e remain engaged with the track members 2a, 2b of the middle track.

The first set of drive units 8b, 8d and 8f are then moved, together with the associated ram mechanisms 12d, 12d and 12f, laterally relative to the vehicle, using the slide mechanisms 13a - 13c, to a position where they can become subsequently re-engaged with the track members 2e, 2f of one of the two adjacent tracks, as shown in Figure 4(c). At this stage, each of the six drive units 8a - 8f is engaged with one of the four track members 2a, 2b, 2e, 2f of two adjacent tracks.

The second set of drive units 8a, 8c and 8e are then disengaged from track members 2a, 2b of the middle track, so that the vehicle is engaged solely with the track members 2e, 2f of the adjacent track.

The vehicle, together with the second set of drive units 8a, 8c and 8e and associated ram mechanisms 12a, 12c and 12e, is then moved laterally with respect to the first set of drive units 8b, 8d and 8f, again using the slide mechanisms 13a - 13c, to a position where the vehicle is centred between the track members 2e, 2f of the adjacent track. From this position, the second set of drive units 8a, 8c and 8e are then re-engaged with the track members 2e, 2f using the ram mechanisms 12a, 12c and 12e, as shown in

Figure 4(e). The vehicle is now fully engaged with the track members 2e, 2f.

The following additional features, which are considered to be independently inventive, are preferably included in systems in accordance with the present invention:

(a) In a system including a plurality of such vehicles, it is intended that all the vehicles will travel at substantially the same speed. However, a Doppler device may be provided in each vehicle which detects any relative motion of two adjacent vehicles so as to provide additional speed control to prevent collisions.

(b) A back-up battery may be provided within each vehicle in case of power failure.

(c) The vehicles may include a data read device for reading data from a memory device positioned on the track, the data relating to the desired speed for that particular section of track, or to the existence of a secondary track on to which the vehicle could transfer. The memory device is preferably arranged to be updated without causing interruption of the traffic.

(d) Each vehicle may be further provided with an on-board computer, linked by satellite communication or radio waves to a central control, which stores all route maps and possible destination points of the track system and which can be updated automatically from the central control and which can monitor all functional aspects of the vehicle to ensure that any fault is detected prior to causing a problem.

(e) The system may include card programming and reading wherein a user holds a prepaid card and enters a desired destination onto the card at a collection point. The vehicle would include a card processing unit, e.g. in the door of the vehicle, which would be connected to the on-board computer so as to enable the unit automatically to plot the route to the desired destination and open the door(s) for the user on condition that the vehicle is unoccupied.

(f) In the above case, the user may re-insert the card into an internal card reader when ready to depart, which would instruct the unit to close the vehicle door(s) and to proceed

directly to the desired destination; such a system may permit multiple users to insert their respective cards and would adjust the credit remaining on the cards so as to split the cost of the journey between the passengers.

(g) The vehicles may be programmed to remain at any position only on condition that no other approaching vehicles require disembarkation of passengers at that position, in which case the vehicle would move to the nearest vacant collection point or circulate until requested to proceed to a collection point. Such a request would be relayed to all vehicles by satellite or radio communication and each unoccupied vehicle would respond with its estimated time of arrival (ETA). The vehicle with the shortest ETA would then be selected to proceed to the collection point.

(h) Each vehicle may be preprogrammed with a maintenance schedule such that, after completing a predetermined mileage, it would, after completing the current passenger service, proceed automatically to its maintenance depot for preventative maintenance.

(i) The vehicle, while normally arranged for conveying passengers, may be re-structured for conveyance of freight direct from source to destination.

CLAIMS:

1. A tracked vehicle system comprising:
first and second fixed tracks for guiding vehicles along first and second paths respectively;
a vehicle comprising a plurality of track-engaging members; and
means for causing the track-engaging members to disengage the first track and subsequently to engage the second track thereby to cause the vehicle to travel along the second path.

2. A system as claimed in claim 1, wherein a portion of said first track is adjacent and substantially parallel to a portion of said second track.

3. A system as claimed in claim 2, wherein said portions are of sufficient length to enable the vehicle to disengage said first track and to engage said second track while moving at a predetermined speed.

4. A system as claimed in any preceding claim, wherein said track comprises two track members and said plurality of track-engaging members comprises at least four such members, each track member having at least one track-engaging member associated therewith.

5. A system as claimed in any preceding claim, where each track comprises first and second track members and said plurality of track-engaging members comprises first and second sets of three members, said first set being arranged to engage said first track member and said second set being arranged to engage said second track member.

6. A system as claimed in claim 5, wherein two track-engaging members from said first set and one track-engaging member from said second set are arranged to disengage said first track and to engage said second track before the other track-engaging member from said first set and the other two track-engaging members from said second set, such, that, at any one time, at least three

track-engaging members are engaged to one of said tracks.

7. A system as claimed in any preceding claim, wherein said first and second track members of each track are located at opposite sides of the path associated with its respective track.

8. A system as claimed in claim 7, wherein each of said first track members is arranged above the vehicle and each of said second track members is arranged below the vehicle.

9. A system as claimed in claim 7 or claim 8, wherein said first path includes a bend, the track members being relatively oriented at that bend so as to cause the vehicle to bank, thereby at least partially to compensate for the circular motion of the vehicle.

10. A system as claimed in any preceding claim, wherein the vehicle is powered electrically and electric power is supplied to the vehicle by means of a first conductor attached to the track.

11. A system as claimed in claim 10, wherein the first conductor is electrically insulated from the track.

12. A system as claimed in claim 10 or claim 11, wherein each track member is substantially Y-shaped in cross-section, the electrical power being supplied at a location between the two limbs of the Y.

13. A system as claimed in an preceding claim, wherein each track-engaging member comprises at least one wheel.

14. A system as claimed in any one of claims 10 to 13, wherein each track-engaging member comprises two wheels between which is located a second conductor for conducting electric power from the track.

15. A system as claimed in claim 13 or claim 14, wherein the wheel or wheels of each track-engaging member are driven by a respective electric motor disposed coaxially with respect to the wheel or wheels.

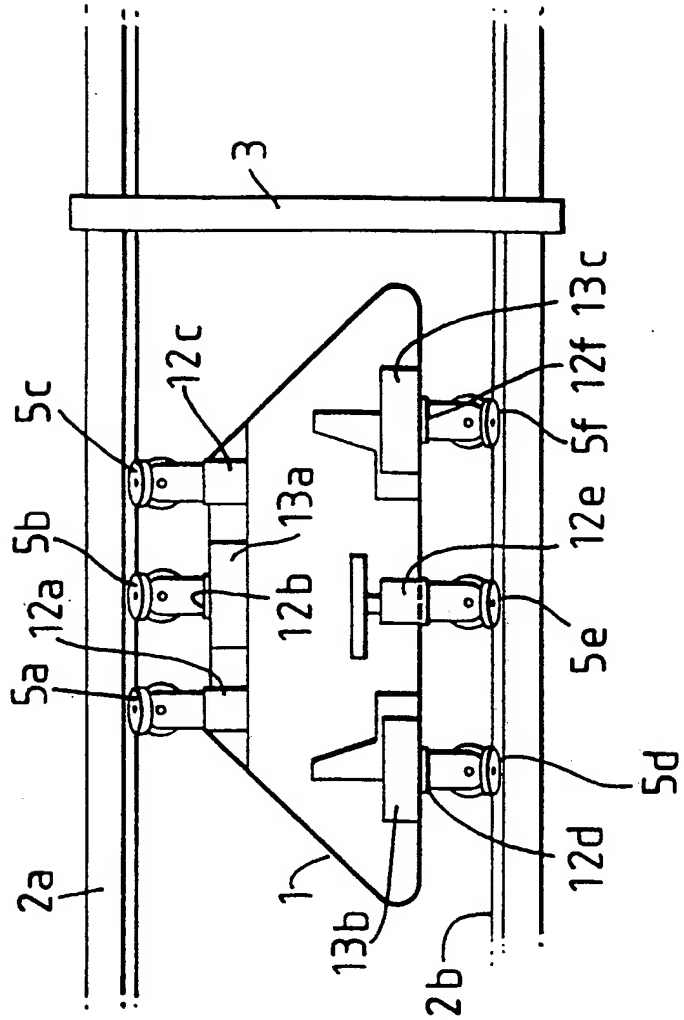
16. A system as claimed in any preceding claim, comprising a plurality of such vehicles.

17. A track for guiding vehicles along a path, the track comprising a first track member arranged above the path and a second track member arranged below the path.

18. A track as claimed in claim 17 comprising a bend, wherein the track members are relatively oriented at that bend so as to cause a said vehicle to bank, thereby at least partially to compensate for the circular motion of the vehicle at that bend.

19. A track as claimed in Claim 18 comprising a plurality of bends, wherein the track members are relatively oriented at the bends by an amount which substantially compensates for the circular motion of the vehicle when the vehicle is travelling at a predetermined speed, the predetermined speed being the same at each bend.

FIG. 1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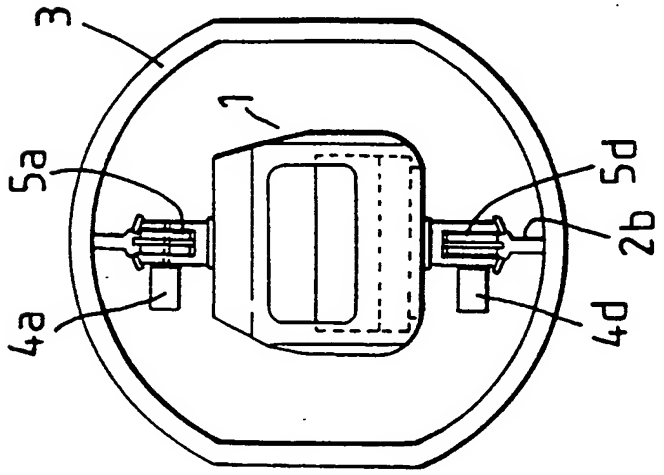
13b
2b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4d

FIG. 2

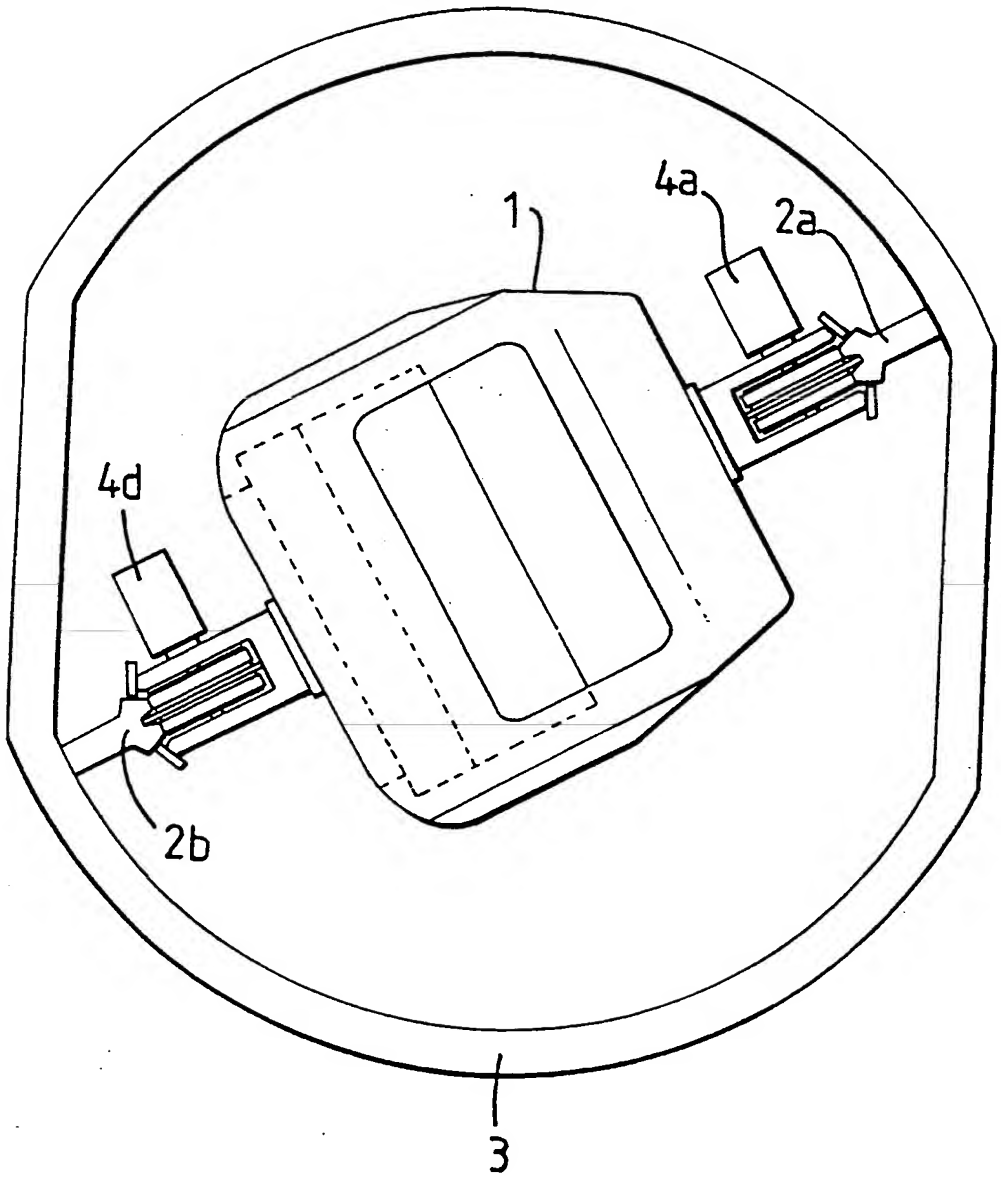


FIG. 3

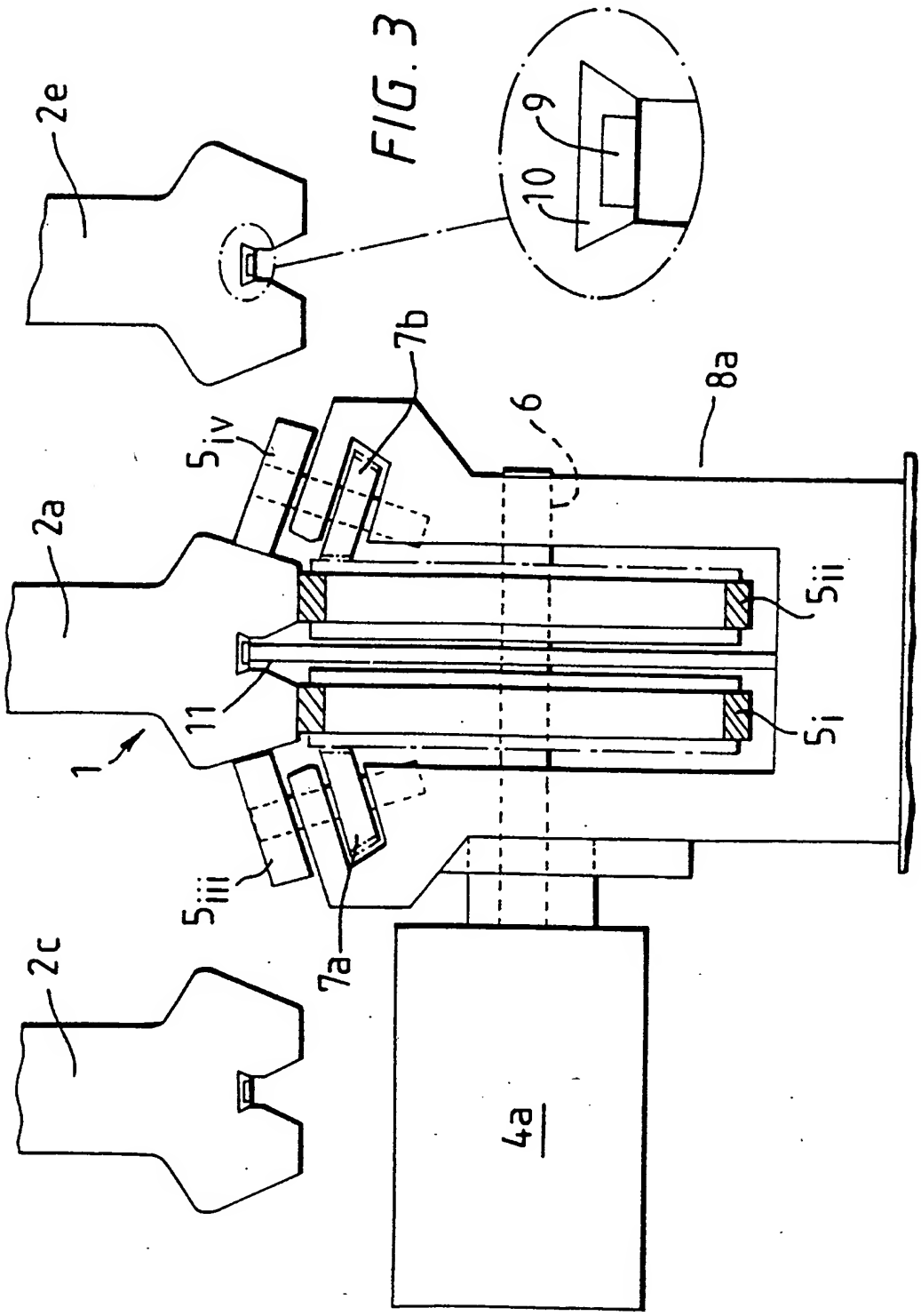
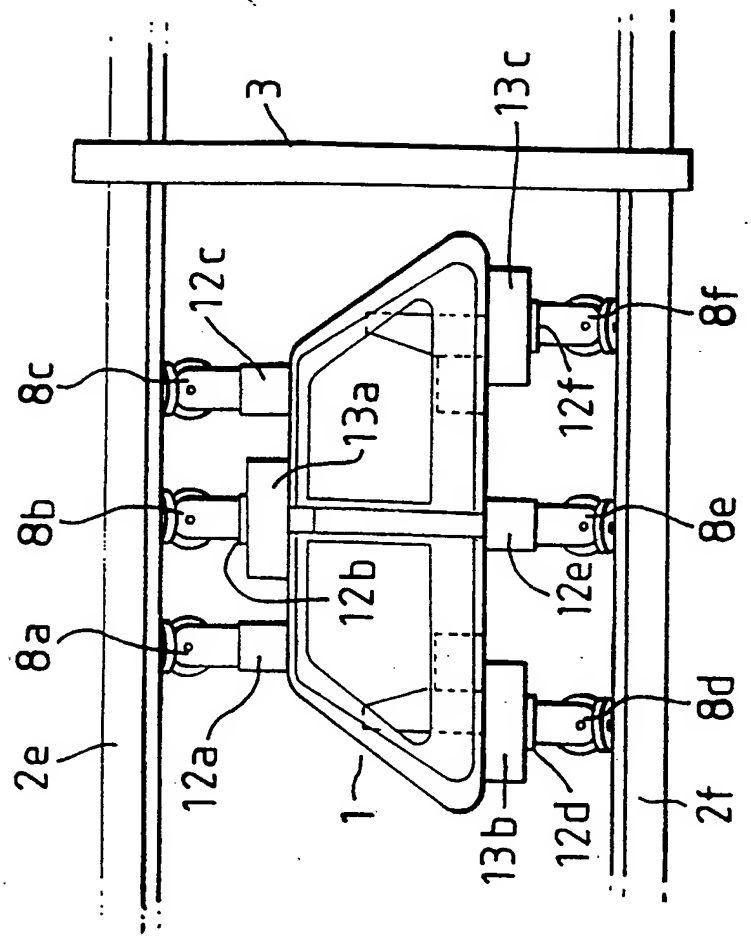


FIG. 4(a)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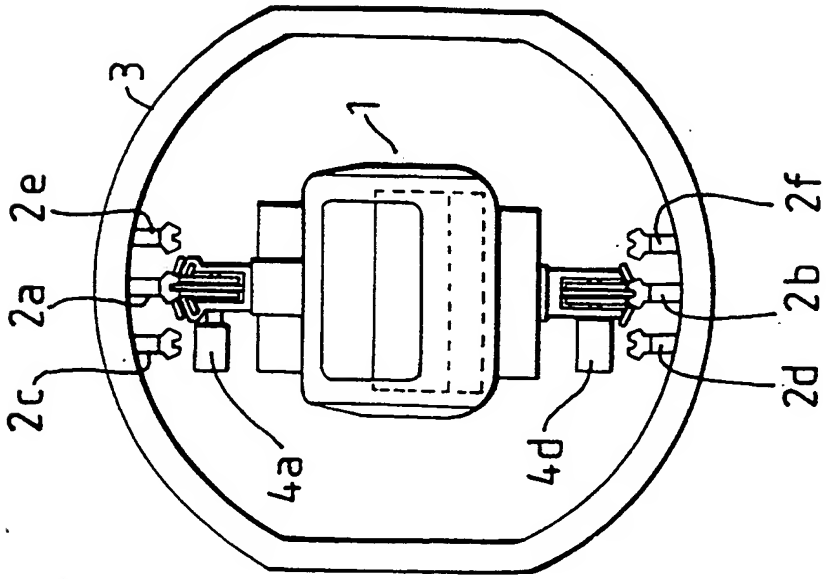
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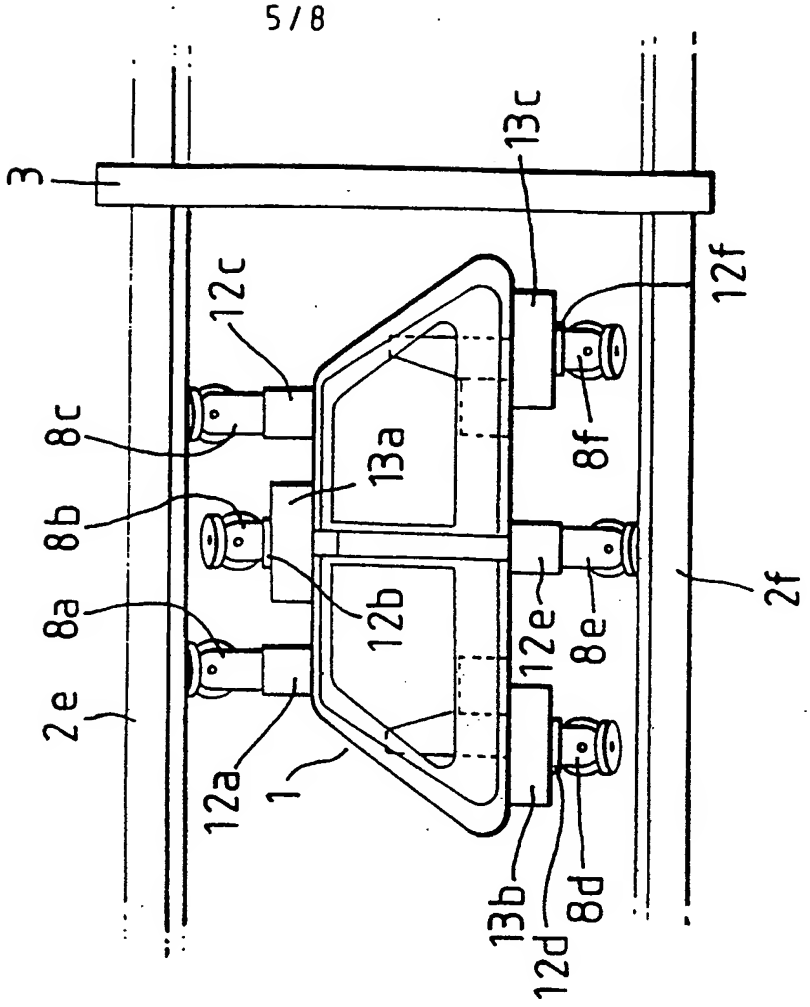
FIG. 4(b)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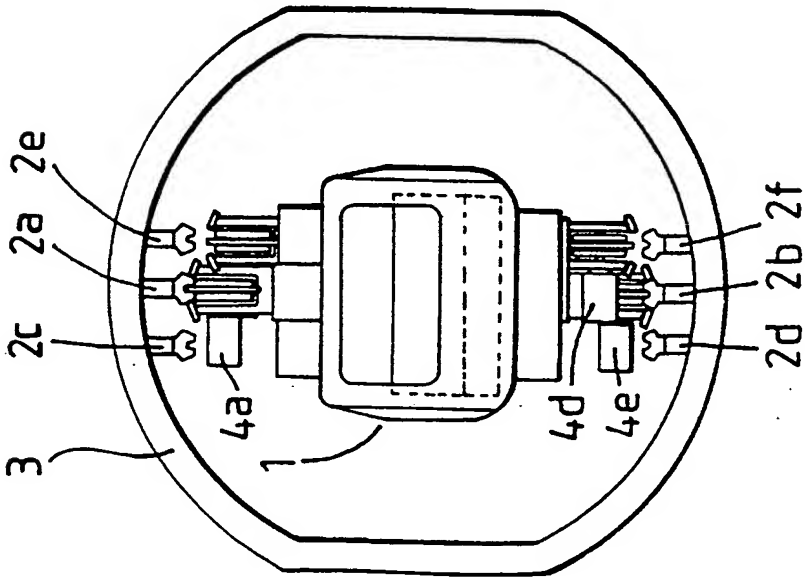
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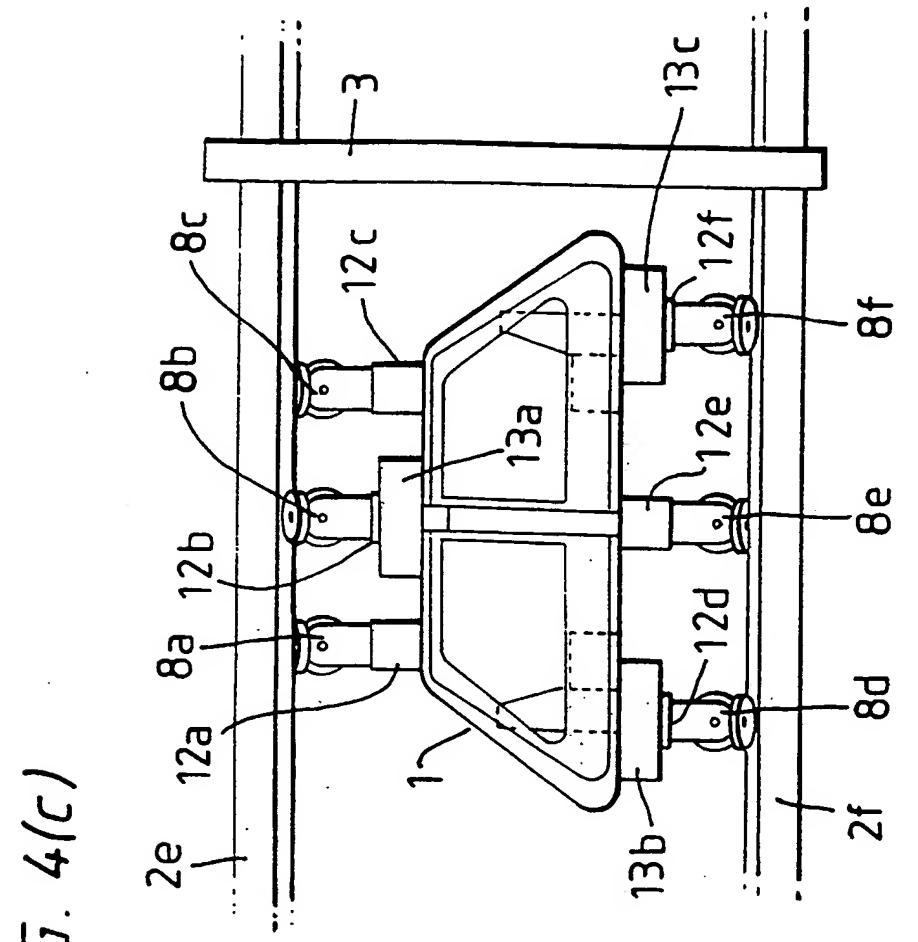
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FIG. 4(c)

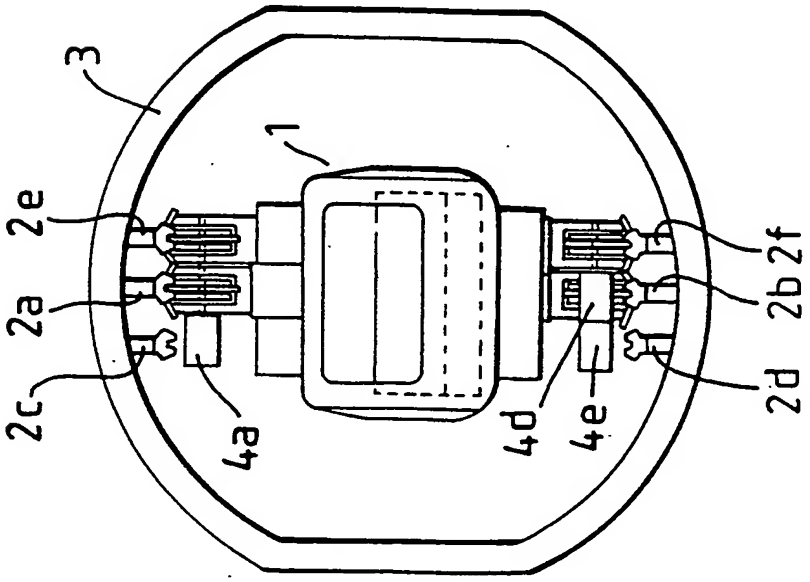
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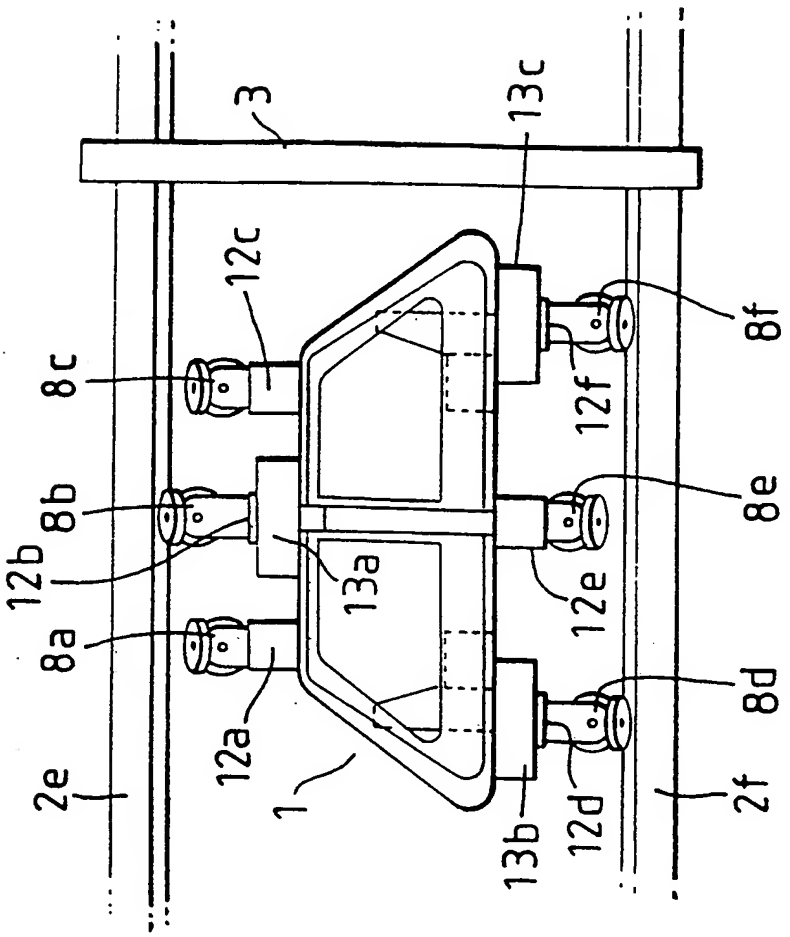
FIG. 4(d)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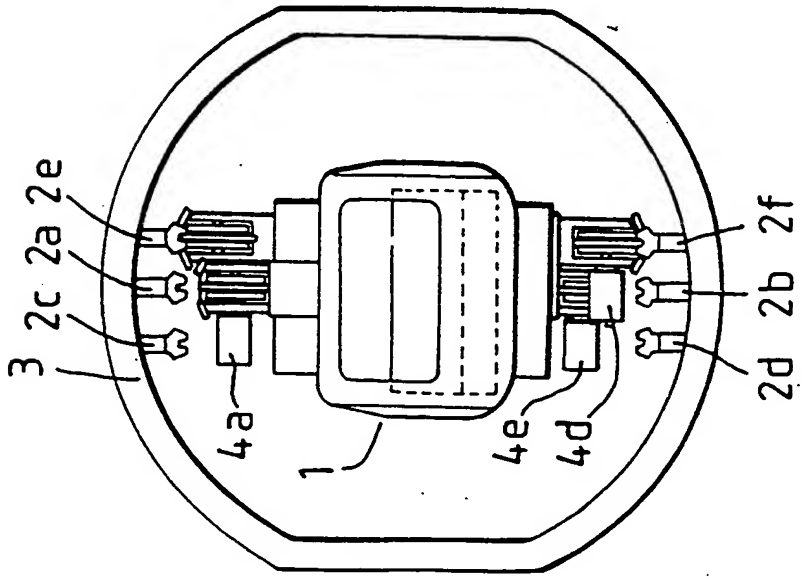
13b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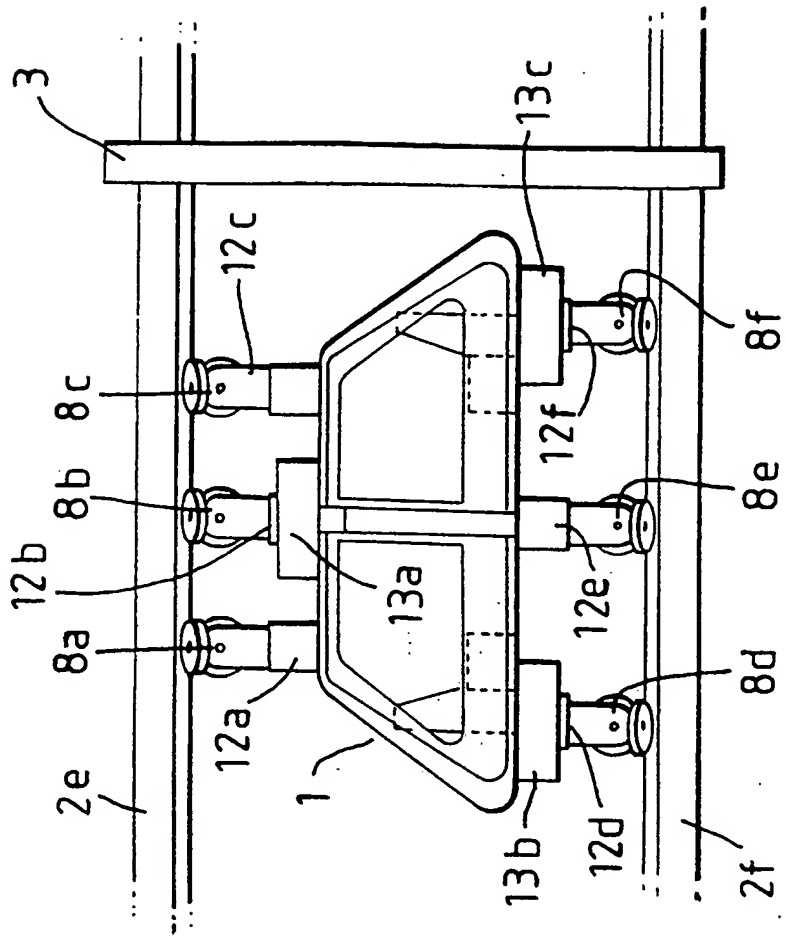
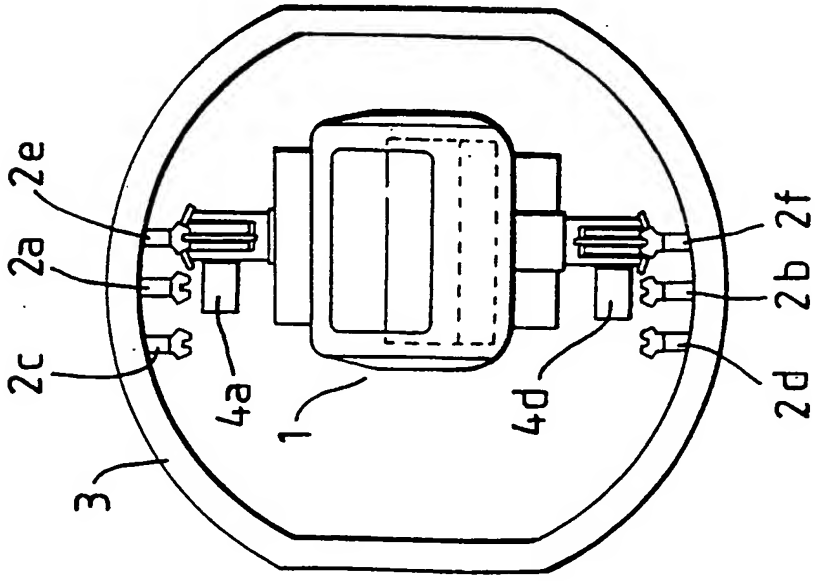
2d

FIG. 4(e)


3
13c
12c
8f
8c
8b
12f
8e
12b
13a
12e
8a
8d
12a
1
2e
13b
12d
2f


2e
2a
2c
4a
1
4d
2f
2b
2d
3

INTERNATIONAL SEARCH REPORT

Ir. ational Application No
PCT/GB 98/03576

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B61B5/02 B61B13/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B61B B61C B61F E01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 648 621 A (FLEMING KENNETH C) 14 March 1972 see column 4, line 18 - column 9, line 22; figures 1-6	1-4
X	US 3 640 227 A (WEBB AUSTIN A) 8 February 1972 see column 1, line 62 - column 3, line 38; figures 1-3	1
A	US 4 195 576 A (GUTRIDGE JACK E) 1 April 1980 see column 2, line 43 - column 3, line 65; figures 1-3	17

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 February 1999	22/02/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Chlosta, P

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 98/03576

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 21 26 494 A (G. HUBMANN) 7 December 1972 see page 5, paragraph 4 - page 7, paragraph 2; figures 1-3	17

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INTERNATIONAL SEARCH REPORT

Information on patent family members

I. national Application No
PCT/GB 98/03576

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3648621 A	14-03-1972	NONE	
US 3640227 A	08-02-1972	NONE	
US 4195576 A	01-04-1980	CA 1071025 A	05-02-1980
DE 2126494 A	07-12-1972	NONE	